method will you use to find your answer?" "Show me how to get your answer and tell me what you are thinking as you do it." "Write down your answer." "Tell me how you think you could check whether your answer is correct?"

Using Word Problem Solving Prompts to support NESB students


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In this article Debbie Verzosa and Joanne Mulligan suggest a new approach to addressing the difficulties that NESB students encounter when solving word problems.

Many young children may find it difficult to solve mathematical word problems even if they are capable of carrying out the necessary operations required by the problem. It is common even for children whose first language is English to be impeded by the linguistic demands of a problem (Perso, 2009). Children who can untangle the linguistic complexity of a problem may still fail if they cannot apply their mathematical knowledge to the problem situation. In this article, we propose a new approach to scaffolding mathematical word problems in a way that makes them appropriate to a child's stage of language acquisition.

To investigate the sources of children's difficulties, Newman (1977; refined by White, 2005) proposed individual structured interviews that consist of five stages or prompts:

- Read the question to me.
- What is the question asking you to do?
- What method will you use to find your answer?
- Show me how to get your answer, and tell me what you are thinking as you do it.
- Write down your answer.

While the Newman interview has been used extensively across many countries for a long time (e.g., Clements & Ellerton, 1992; White, 2009), its use is limited if a child is in the early stages of learning English. This is the case for many children in Australia, such as Indigenous children in remote communities or recent immigrant children who have yet to experience schooling in English. Children learning a second language may be expected to go through five stages of language acquisition (Krashen & Terell, 1983; see Table 1), so it is crucial to give questions or prompts that are appropriate for their stage (Hill & Björk, 2008).

It is easy to see that the Newman prompts do not pose any problems for a child in the intermediate fluency or advanced fluency stages described here. However, these same prompts may not give useful information when a child is still in the first three stages of language acquisition.

A new approach

We propose a set of prompts that provide more opportunities for children in the first three stages of language acquisition to engage in mathematical word problems and rich challenging tasks. Without such prompts, these tasks are often inaccessible due to these children's language difficulties. Our approach was drawn from our work with second-grade Filipino children who learn

Table 1. Stages of language acquisition, with corresponding prompts (Krashen & Terell, 1983; Hill & Björk, 2008).

Stage	Characteristics	Appropriate prompts
Pre-production	Understands few words. Seldom speaks, mostly nods "yes" or "no", draws, or points.	Show me… Point to the… Who is the…?
Early production	Can produce one-word responses.	Yes/no questions Either/or questions Who? How many?
Speech emergence	Can produce simple sentences for daily conversation (e.g., for buying items), but makes grammatical errors for more complex sentences.	Why? How? Explain…
Intermediate fluency	Can produce longer sentences and more complex statements (e.g., for communicating thoughts or opinions).	Why do you think…? What if…?
Advanced fluency	Attains proficiency comparable to native speaking peers.	Decide if… Retell…

mathematics in English even when they had not acquired conversational fluency in the language (Verzosa & Mulligan, 2011). The same situation applies to many Australian students whose home language is not English. For Indigenous students, this language may be an Indigenous language, Aboriginal English, or a creole. For recent immigrants, it may be a major language in their country of origin. The conditions for learning available to these students are very limited, considering that they may not fully engage in a task only because they have limited knowledge of English. Teachers seeking to engage these students fully need to find ways to present learning tasks through a more accessible medium.

Of course, an obvious solution is simply to translate word problems to the child's first language. This removes language obstacles and can enable children to access the problem task. However, this scaffold alone was often found to provide minimal help, especially when children could not conceptualise the structure of the word problem. To illustrate, consider the missing addend problem:

> Jolina had 8 pencils. Then Alma gave her some more pencils. Now Jolina has 14 pencils. How many pencils did Alma give her?

The first column in Figure 1 shows how many children in our study failed to solve this problem even when it was written or narrated in their first language (Filipino). These children could not conceptualise a set as being part of another set, and some children insisted on first knowing what the missing addend was, before they could proceed with a solution. In this problem, they failed to think of 8 as part of the 14. Some of them also applied a default strategy: they solved all word problems by adding the two given numbers. One can hardly blame them, considering that they do not understand relatively simple sentences such as, "Jolina had 8 pencils." These limitations prevented them from solving a missing addend problem even when linguistic demands had been significantly eased.

It is evident that linguistic prompts are not always adequate to guarantee success. Our teaching strategy therefore provided a variety of representational tools in order to communicate mathematical tasks and concepts. We provide an illustration through representations of a missing addend task (see Table 2). We chose this task because many children in our study initially could not solve it.

The questions that we presented for each of these representations could be further modified so that they are appropriate to the child's stage of language acquisition (see Table 3).

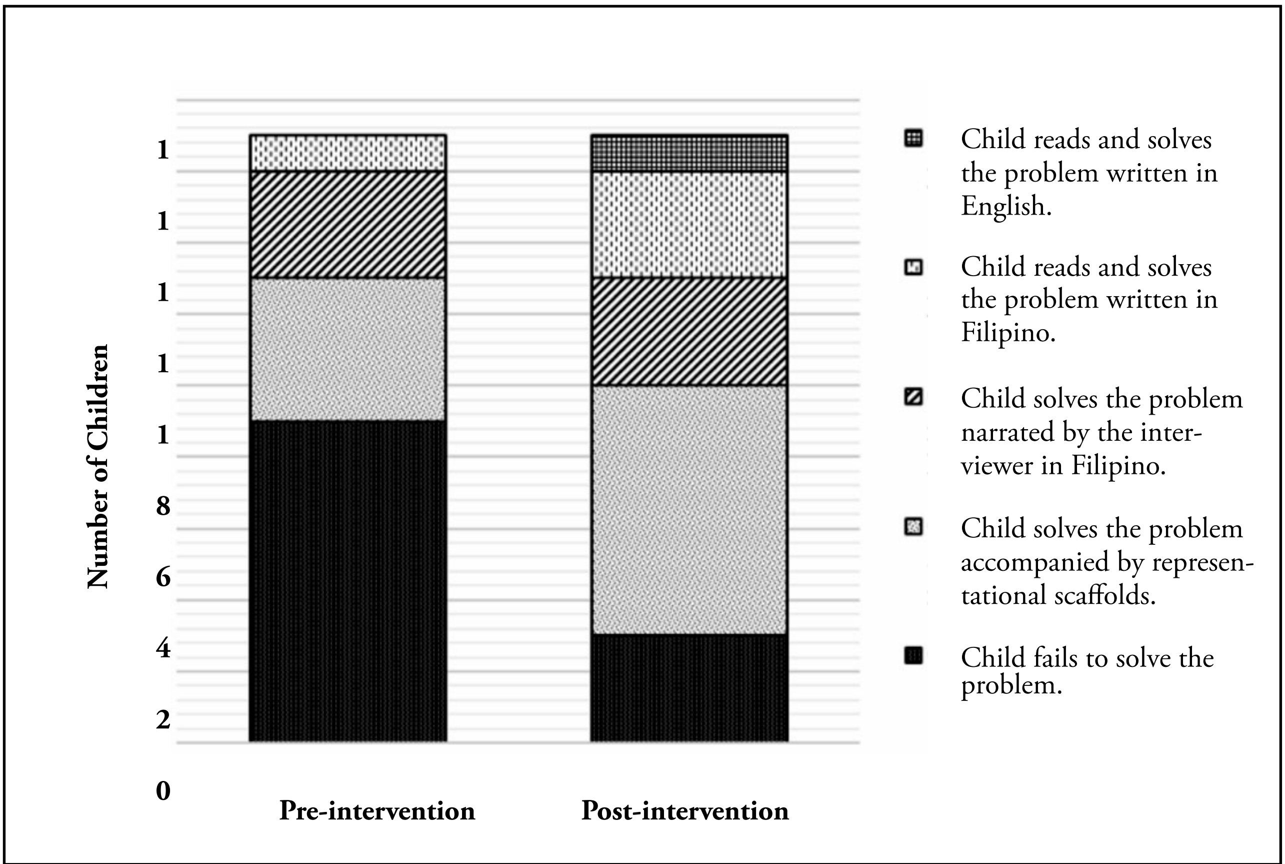


Figure 1. Enabling scaffolds for a missing addend problem.

Table 2. Various representations for the missing addend task 8 + □ = 14.

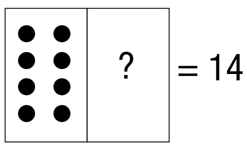
Mode of representation	Typical tasks or activities
Concrete	Screening task (Wright, Martland & Stafford, 2000): Briefly display 8 blocks. "I will join some blocks to the 8, but I will not tell you how many." Join 6 blocks to the original 8, without showing the child the number of additional blocks. "Now, there are 14 blocks altogether. How many blocks are in the bag?" [presented in Filipino]
Pictorial	
Verbal–pictorial	"Wish ko lang [I wish I had]" task (Kolson, Mole & Silva, 2006): Show 8 dots. "I have 8 dots. I wish I had 14. How many dots do I need?" [presented in Filipino]
Symbolic	8 + □ = 14

Table 3. Modified prompts for the first three stages of language acquisition.

Stage	Appropriate prompts
Pre-production	Draw how many dots are needed. Get the number of blocks that show your answer. Use the blocks to check your answer.
Early production	Do you think that 7 is the correct answer? How many dots are needed?
Speech emergence	Tell me how you could check whether your answer is correct.

Affordances of representational tools

Admittedly, our use of representational scaffolds and modified questions can reduce the difficulty of word problems. It also limits the opportunities for children to read and interpret questions, which are necessary components of numeracy (Perso, 2009). Nevertheless, we encourage the use of these scaffolds, at least until children reach higher stages of language acquisition. Otherwise, it will become impossible to expose them to a range of problem structures, and there may be a tendency to expect them to answer the same kind of low-level question over and over again.

We used our scaffolds during a four-week teaching intervention focused on different types of additive word problems, one of which was the missing addend problem. These scaffolds were often accompanied by a range of prompts that were appropriate for children in the first three stages of language acquisition. As mentioned earlier, some children could not solve this problem even when the problem situation had already been translated to Filipino or narrated to them (see the first column in Figure 1). This failure suggested that the source of their difficulties was not just linguistic but also mathematical. The representational tools allowed children to develop the mathematical knowledge required for conceptualising the situation described in the missing addend problem.

We now describe one teaching episode where such prompts were successful in conveying mathematical structures that children initially could not conceptualise. In this episode, the teacher presented three children the following problem in Filipino:

> Ed had 4 pieces of bread. Then he bought more bread. Now he has 9 pieces of bread. How many pieces of bread did Ed buy?

Although the children had no trouble reading the words, they did not comprehend the text fully. Even when the teacher narrated the problem to them in Filipino, they produced 9 as the answer because as one child reasoned, "Bumili siya ng nine [She bought nine]." They clung to their answer even when the teacher prompted them to draw 4 pieces of bread and a bag and to think how many pieces are needed in the bag to make 9. It was only when the teacher drew a piece of bread inside the bag and asked them if there were already 9 pieces that they began to conceptualise a set having an unknown quantity.

Prompting children to draw or use blocks often led to success, even for other types of word problems. In the problem, "There are 43 children, and 15 are girls. How many are boys?", children were prompted to first draw a representation of the 43 children, and to encircle 15 of these (see Figure 1). This strategy also discouraged children from adopting their default strategy of performing an addition. Notice that children were also encouraged to draw in groups of ten.

As representational scaffolds were frequently provided to the children during the intervention, these eventually enabled more children to solve a missing addend problem (see Figure 2). These scaffolds were critical because linguistic scaffolds alone did not always facilitate correct solutions. Further, these scaffolds, when presented using appropriate language, allowed children to think about new mathematical situations.

Figure 2. One child's drawn representation of a problem.

Conclusions

Children in all stages of language acquisition have a right to access quality mathematics teaching that differentiates for their abilities and needs. Teachers should ensure that a child's lack of familiarity in English does not prevent him or her from accessing new mathematical knowledge. In this article, we proposed a process for modifying mathematical tasks in a way that makes them appropriate to a child's stage of language acquisition. We also showed that one should not dismiss all difficulties of NESB students as stemming from language difficulties. As such, translating word problems to a child's home language does not always result in correct solutions. The challenge is how to help children conceptualise a larger range of mathematical situations while also providing prompts that are appropriate to their level of language acquisition. In this sense, representational tools can supplement oral language and convey mathematical structures that are initially beyond the learner's grasp. Thus, these representational tools can provide children with opportunities to develop their mathematical understandings independently of their linguistic difficulties.

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